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OVERWEIGHT, CALCIUM INTAKE, AND CALCIUM LEVELS IN A GROUP OF CHILDREN IN TÉBESSA

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ABSTRACT:

The research focused on 200 healthy children aged between 1 and 24 months, chosen randomly. For each participant, information on the child and household characteristics were collected via questionnaire. The children's body weight was assessed using the body mass index for age (BMI/Age) ratio, based on height and weight measurements. To categorize the children, the World Health Organization's (WHO) pediatric references from 2006 were used. The children's calcium intake was determined using the 24-hour recall method. Finally, a blood sample was taken to determine the calcium level. The study found that 31.5% of the total population were overweight. Out of all the children affected, 17% have overweight and 14.5% have obesity. A low intake of calcium is considered a major risk factor in the development of overweight and obesity in children. Studies have revealed that there is an inverse relationship between the body size of children and the level of calcium intake and blood calcium levels. Moreover, those who are overweight and obese have the lowest mean calcium intake and blood calcium levels in the population. Further evidence suggests that BMI increases significantly with decreasing calcium intake and blood calcium levels.

Keywords calcium intake; calcemia; overweight; obesity; children.

1. INTRODUCTION

Obesity, with a focus on childhood obesity, is becoming increasingly prevalent in recent years. This growth is so notable that obesity is currently recognized as a major public health problem across the globe [1]. According to a study conducted by the World Health Organization (WHO), the number of obese or overweight children worldwide has increased by 60% over the last 20 years [2]. Between 1990 and 2013, cases of childhood overweight across the globe have increased. Notably, the number of affected children rose from 32 to 42 million. In 2014, almost half (48%) of all overweight and obese children under the age of 5 were living in Asia, and another quarter (25%) were living in Africa. The number of overweight children who are under 5 years old in Africa has nearly doubled since 1990. In the WHO African region alone, the number of children who are overweight or obese has increased from 4 to 9 million during that same period. In developing countries, the incidence of overweight and childhood obesity in preschool-aged children is 30% higher. If the current trend continues, there will be 70 million overweight infants and young children by 2025 [3]. Over the past few years, there has been a significant increase in the number of children who are overweight or obese, which corresponds with a decline in their daily intake of dairy products. This trend has led to increased interest in fad diets and miracle weight loss products. From a scientific perspective, multiple studies are exploring potential explanations and effective solutions to this widespread weight gain. In this regard, the link between calcium and weight regulation is increasingly being examined. According to many experts, ensuring sufficient dietary calcium intake may help prevent the development of overweight and obesity.

Within this context, we conducted a descriptive and analytical cross-sectional study aimed at determining the prevalence of overweight and obesity, evaluating calcium intake and calcium levels among a group of children aged 1-24 months in Tebessa. Our results provide insight into the link between calcium consumption and child's weight overweight.

2. METHODOLOGY

The study was conducted in Tébéssa, an Algerian city in the east, involving infants aged between 1 and 24 months, as this age group is particularly vulnerable during the transition from breastfeeding to a mixed diet, which typically lasts from 6 to 18 or 24 months. Furthermore, this age range could be an opportune period for prevention strategies and therefore deserves special attention.

Population of Study

The survey was performed with 200 healthy children of both genders aged between 1 and 24 months. To compare the characteristics of children by age group and gender, we investigated the same number of boys and girls, distributed into five uniform age groups in compliance with WHO recommendations (40 children per age group).

Overweight Status of Children

The weight status of children was assessed by calculating the body mass index for age (BMI/Age) ratio, based on weight and height measurements using the formula: $BMI = W/H^2$ (KG/m²). To classify children, we used the WHO's (2006) [6] pediatric references. The means z-scores of the BMI/Age ratio were determined using the WHO Anthro software (2006).

Calcium Intake

To estimate the daily calcium intake of children, we used the 24-hour recall method because of its simplicity, speed, and low cost. This method involves asking the mother to recall and

describe in detail all foods and beverages consumed by the child during the 24 hours prior to the survey, including the quantity and order of consumption.

For tracking the calcium intake of children, we have a database on food composition and a computer program that enables calculations. This program is a compilation of tables on the composition of foods, and it allows for the calculation of daily calcium intake for each child. For composite dishes, calculations based on recipe ingredients have been made.

The calcium content of breast milk is estimated based on literature data. With respect to calcium intake from mineral water and infant formula, we consult the packaging labeling for commercially available brands in the Algerian market according to the brands mentioned by mothers.

Calcemia

In this study, blood samples were drawn from fasting children using a conventional approach and the calcium levels were measured from plasma using a colorimetric method in the medical analysis labs within in healthcare facilities where our survey was conducted.

Statistics

Data collection and analysis were performed using Excel 2007 software, and statistical tests were conducted using Minitab version 16.

The aim of this study was to compare the average calcium intake and calcium levels in overweight and obese children with those of normal-weight and underweight children. To achieve this, mean comparisons were carried out using Student's t-test, and frequency comparisons were evaluated through the Chi-squared test. To identify the relationship between the measured quantitative variables, the correlation test was used.

All test results were considered statistically significant at a level of $\alpha = 5\%$.

3. RESULTS

Overweight Status of Children

We conducted a study on 200 children, including 100 girls and 100 boys, with an average age of 10.97 ± 6.63 months. Table 1 illustrates the main anthropometric averages by age group and gender. Children grow and their weight and height increase naturally with age.

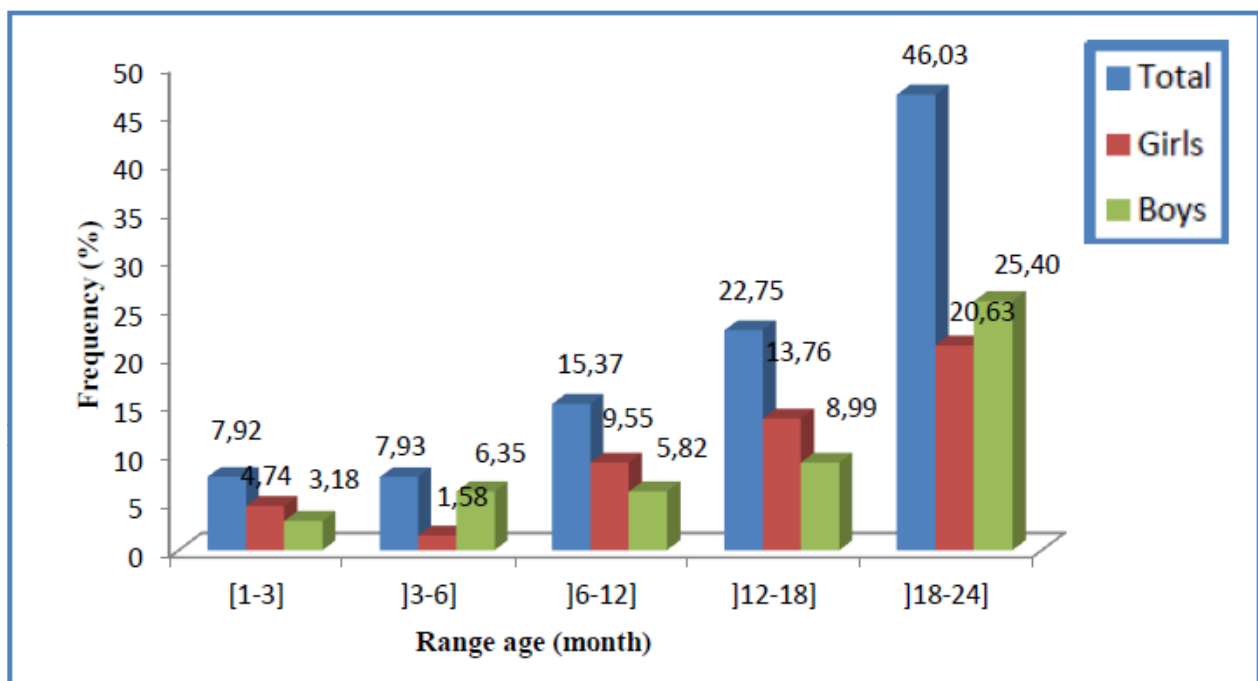
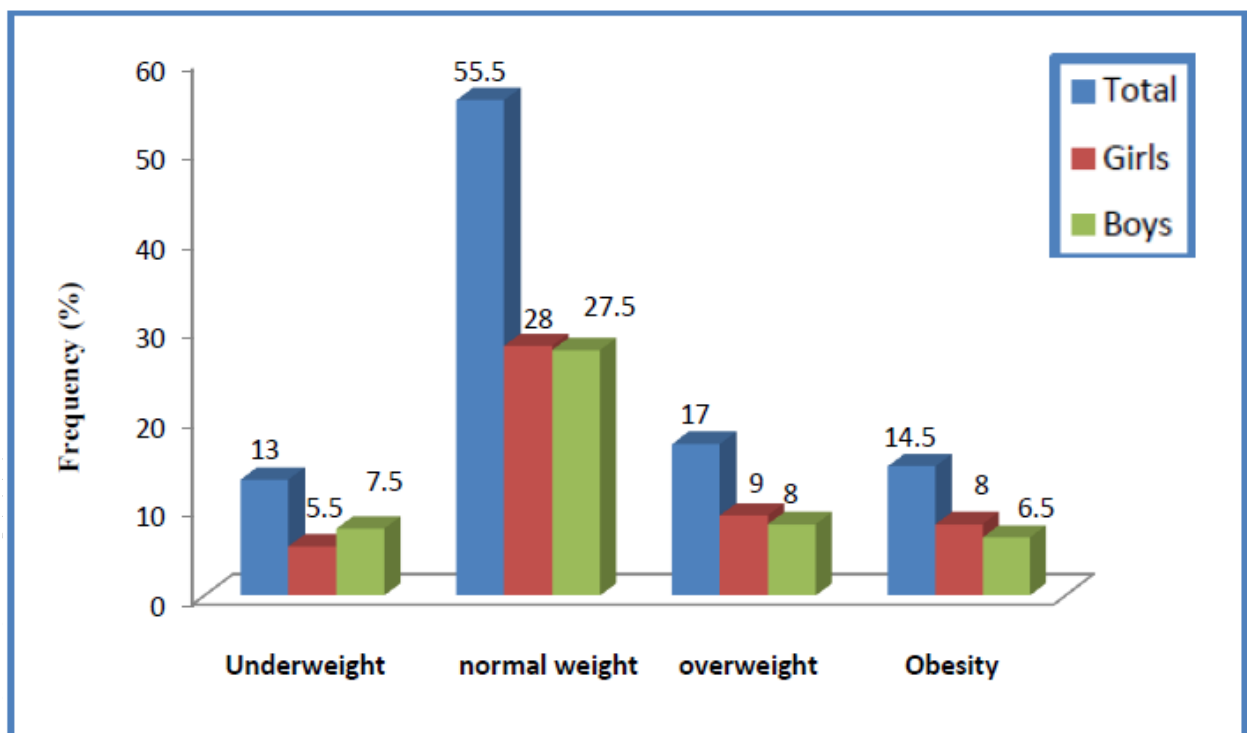
Despite the lack of significant difference, girls generally have higher average weight and BMI than boys in every age group.

Table 1: Average Anthropometric Characteristics of Children by Age Group and Gender

Parametrs	Age (month)	Total	Girls	Boys	P
Weight (kg)	[1-3]	5,03 ± 1,04	5,22 ± 1,22	4,95 ± 0,80	0,051
	]3-6]	6,71 ± 1,07	6,97 ± 0,92	6,51 ± 1,08	0,262
	]6-12]	9,42 ± 1,73	9,83 ± 2,05	8,92 ± 1,26	0,971
	]12-18]	11,35 ± 1,41	11,71 ± 1,56	11,25 ± 1,32	0,426
	]18-24]	14,01 ± 2,72	14,25 ± 3,12	13,89 ± 2,64	0,151
Height (cm)	[1-3]	55,83 ± 5,82	56,12 ± 5,43	55,62 ± 6,42	0,364
	]3-6]	64,12 ± 4,25	64,04 ± 4,53	64,21 ± 4,34	0,057
	]6-12]	71,27 ± 5,03	70,71 ± 3,78	71,93 ± 6,16	0,264
	]12-18]	78,52 ± 5,28	78,52 ± 4,63	78,89 ± 6,25	0,192

	]18-24]	82,27 ± 4,52	81,41 ± 4,86	83,41 ± 3,84	0,339
BMI (Kg/m ²)	[1-3]	16,31 ± 2,86	16,28 ± 2,16	15,57 ± 2,86	0,257
	]3-6]	16,23 ± 2,63	17,11 ± 2,81	16,15 ± 3,24	0,054
	]6-12]	18,31 ± 3,13	18,68 ± 3,37	17,91 ± 2,61	0,523
	]12-18]	18,57 ± 2,89	18,78 ± 3,48	18,26 ± 2,72	0,412
	]18-24]	20,81 ± 3,81	21,24 ± 3,25	20,47 ± 4,21	0,247

The distribution of children based on the BMI/A index (Figure 1) reveals that 55.5% of children have a normal body mass. 13% of children are underweight whilst 31.5% are overweight; of those, only 17% are considered to be overweight and 14.5% are classified as obese.



The average calcium intake of children (Table 2) is below the recommended nutritional intake (400mg/day) for the age group [1-3] months. It complies with the nutritional recommendations (500mg/day) for the age group]3-6] and exceeds the reference levels for the remaining children [7]. However, 42% of children have calcium intake lower than the age-appropriate nutritional recommendations.

Table 2: Average calcium intake of children by age group and gender.

Parametrs	Age(month)	Total	Girls	Boys	p
Calcium intake (mg/day)	[1-3]	270,74 ± 124,94	269,78 ± 121,74	272,72 ± 114,45	0.174
	]3-6]	515,99 ± 255,26	513,89 ± 245,25	520,92 ± 252,18	0.852
	]6-12]	722,05 ± 397,26	721,15 ± 378,14	727,09 ± 386,19	0.464
	]12-18]	1002,42 ± 392,95	1001,32 ± 389,69	1003,47 ± 394,43	0.047
	]18-24]	718,01 ± 376,46	716,02 ± 354,32	719,21 ± 346,59	0.881

The correlation study shows no significant link between calcium intake and age for children aged 1 to 24 months. However, calcium intake increases significantly from 1 to 18 months ($r = 0.28$; $p = 0.012$). From 18 months onwards, calcium intake decreases with age, but no significant link has been recorded.

Calcemia

Table 3 presents the average calcemia values of children by age group and gender. We notice that the majority of average values fall within the range of reference values selected in our study (85-105 mg/L).

Table 3: Average calcemia values by age group and gender.

Parametrs	Age (month)	Total	Girls	Boys	p
Calcemia (mg/l)	[1-3]	83,32 ± 6,42	82,41 ± 5,27	84,25 ± 7,55	0,136
	]3-6]	86,12 ± 5,70	85,32 ± 6,13	86,72 ± 5,3	0,252
	]6-12]	90,53 ± 7,32	89,15 ± 8,51	91,65 ± 6,19	0,312
	]12-18]	88,21 ± 8,27	88,32 ± 7,42	88,40 ± 9,34	0,754
	]18-24]	86,62 ± 6,12	86,21 ± 6,63	87,18 ± 5,80	0,321

According to the study results, 63% of children have normal calcemia. We find hypocalcemia in 28.5% of children, while 8.5% of them have hypercalcemia. No significant difference between the genders was observed.

The study's correlation analysis failed to highlight any significant relationship between the age of infants and toddlers (aged 1 to 24 months) and their serum calcium levels. However, after adjusting for age, we found that serum calcium levels significantly increased ($r = 0.59$; $p = 0.024$) between 1 to 12 months of age. After 12 months of age, serum calcium levels sharply declined ($r = -0.06$; $p = 0.017$).

Overweight and Calcium

Table 4 revealed a significant correlation between calcium intake and children's body weight, particularly in overweight children. It appears that overweight children had a significantly lower average calcium intake than their normal-weight peers. Moreover, nearly half of the overweight children (48.67%) demonstrated calcium intakes below the recommended guidelines for their age. Furthermore, it was observed that underweight children exhibited the highest average calcium intake within the overall population studied. A correlation analysis also revealed a significant increase in the Body Mass Index (BMI) of children as calcium intake declines ($r = -0.21$; $p = 0.012$).

Although not significantly different, we also observe that overweight and obese children exhibit lower average blood calcium levels compared to lean and normal-weight children. Moreover, the study highlights a negative correlation between blood calcium levels and children's body weight, with BMI increasing significantly as blood calcium levels decrease ($r = -0.13$, $p = 0.043$).

Table 4: Distribution of children's body weight based on mean calcium intake and blood calcium levels.

	Underweight	Normal weight	Overweight	P
Calcium intake (mg/day)	721,82 ± 397,28	622,05 ± 351,26	512,92 ± 252,18	0,001*
Calcemia (mg/l)	89,34 ± 6,41	84,21 ± 5,27	81,19 ± 7,55	0,230

While blood calcium levels increase with calcium intake, there is no significant correlation ($r = 0.058$, $p = 0.412$).

Table 5 presents that 27.58% of overweight and obese children experience hypocalcemia, which differs significantly from normal-weight and lean children.

Table 5: Distribution of children's body weight based on blood calcium levels.

Calcemia (mg/l)	Underweight (%)	Normal weight (%)	Overweight (%)	P
hypocalcemia	13,51	9,52	27,58	0,039*
Normal serum Calcium	78,38	84,76	68,97	
Hypercalcemia	8,11	5,71	3,45	

4. DISCUSSION

Prevalence of overweight and obesity

In our population, the prevalence of excess weight increases with age in both genders. It is significantly ($p = 0.012$) higher in the age group of [18-24] months, with a rate of 46.03%.

Similar observations were reported in a study conducted on children under 5 in Algeria between 2012 and 2013, which revealed that excess weight is more commonly found in children aged between 12 and 23 months [8].

This can be explained by the fact that in this age range, children have access to an imbalanced diet and tend to consume high-energy foods with low nutritional density [9].

Some dietary changes in children appear to impact their health. One such change is the increase in consumption of sweetened drinks at the expense of milk. Studies from Canada and other parts of the world show that milk, rich in calcium and other health-giving compounds, is being consumed less and less, with sugary drinks filling the gap [4].

Moreover, at this age of children's lives, besides the factors that make them susceptible to obesity (parental obesity, excessive gestational weight gain, high birth weight...), there are also environmental aspects to consider. Modernization is causing shifts in lifestyle in Algeria and other developing countries, which could contribute to an increase in the prevalence of obesity. Hence, it is essential to monitor this epidemic in a country undergoing a nutritional transition. [10]

Overweight and calcium

In our study, 42% of the children had a calcium intake lower than the nutritional recommendations adapted to their age. In the literature, various surveys carried out in

underdeveloped countries have shown a relatively low level of calcium compared to WHO and FAO recommendations [11]. Our results are similar to those of **OULAMARA (2006a)**. The author indicates that this insufficiency is a problem that needs to be explored further, taking into account vitamin D status [12].

Overweight and obese children in our study had significantly lower average calcium intakes than the rest of the population. Moreover, the correlation study shows an inverse relationship between children's BMI, on the one hand, and calcium intake and calcium levels on the other. BMI increases significantly when calcium intake and calcium levels decrease. In addition, 27.58% of overweight and obese children suffer from hypocalcemia. The difference is statistically significant compared to the normo-weight and underweight children.

Several studies have looked at the relationship between obesity and calcium consumption, and inverse relationships have been demonstrated between calcium and adiposity [13]. In light of the rising incidence of childhood obesity, a team of researchers attempted to determine whether adequate dairy intake could aid in weight loss. The researchers found that children who consumed a high amount of milk consumed significantly less carbohydrates and significantly more protein for the same amount of energy ingested. The authors of this research therefore concluded that children with a higher milk intake were at a reduced risk of developing type 2 diabetes and overweight [14].

A study by **ZEMEL et al. (2004)** showed that subjects who consumed a high-calcium diet experienced an average increase of 26% in weight loss [15]. Furthermore, an inverse correlation was also demonstrated between calcium consumption and body fat percentage [16]. Research by **ROSELL et al. (2004)** also found an inverse relationship between calcium consumption and sagittal abdominal obesity [17].

Several other studies have shown the beneficial effect of calcium on body weight and adipose mass in subjects consuming 600 mg of calcium per day [18-19-20]. Newly conducted studies on dairy products indicate their positive contribution to maintaining a healthy weight [13-21-4-15].

The researchers at the University of Tennessee made an intriguing discovery while examining the antihypertensive effect of calcium in the diet of obese African Americans [13]. The study involved the addition of two cups of yogurt to the subjects' daily food intake for approximately one year. Researchers noted that this resulted in a significant reduction in body fat of 4.9 kg, despite no decrease in calorie intake.

Dr. Angelo Tremblay's team observed that drinking or eating 3 to 4 servings of dairy products per day, which is a high source of calcium, would help prevent weight gain [22].

A different study has shown a correlation between dairy product consumption and prevention of overweight and obesity. As previously discussed, observational studies have revealed a lower body fat percentage in a population that consumes adequate amounts of dairy products compared to a population with inadequate consumption [4].

Several mechanisms have been proposed to explain this link between calcium and weight regulation [23-24].

Certain authors suggest that a low consumption of calcium increases parathyroid hormone and 1, 25 vitamin D levels, which would consequently lead to an increase in intracellular calcium concentrations and a decrease in fat oxidation. The resulting high intracellular calcium concentration in adipocytes would stimulate lipogenesis and inhibit lipolysis [25], thereby possibly affecting weight regulation. Conversely, an adequate intake of calcium would lower the amount of calcitriol (1, 25 vitamin D), decreasing the capacity of adipocytes to store fat [15]. Additionally, some studies have shown that calcium supplements increase fat oxidation during weight loss, although this has no effect on total energy expenditure [26].

Another mechanism proposed is that high levels of dietary calcium consumption could lead to greater binding of fatty acids in the colon, thereby reducing lipid absorption. It should be

noted that the fatty acids found in the colon result from bacterial fermentation of fibers. This fermentation gives rise to short-chain fatty acids, which serve as an energy source for the intestinal mucosa and help to maintain the integrity of the intestinal barrier. Calcium binds to these fatty acids, forming insoluble calcium-fatty acid compounds as well as aggregates of hydrophobic compounds including phosphorous, bile acid, fatty acids, and other hydrophobic compounds. This binding could account for how calcium reduces fat absorption while simultaneously increasing fecal excretion of fats [27-28-29].

Calcium may contribute to appetite regulation in situations of energy restriction, although more research is needed to fully understand the mechanism [30-23].

Recent studies have shown that calcium receptors in the gastrointestinal tract are involved in regulating appetite. Specifically, a study found that individuals with low calcium intake (during a calorie-restricted diet) experienced more feelings of hunger than those with adequate calcium intake [31].

5. CONCLUSION

Based on this information, we can conclude that there is an inverse correlation between children's body weight and calcium intake. The prevalence of obesity and overweight significantly increases with children's age, especially between 18 and 24 months. Conversely, calcium intake decreases within this age group. Hence, this phase could be an opportune time for preventive measures that require special attention. Thus, efforts to promote the daily consumption of dairy products, which are a vital source of calcium, should be initiated. Nonetheless, the actual correlation between calcium and weight regulation remains uncertain. The available clinical evidence is still insufficient to establish that calcium has a meaningful influence on weight loss. Consequently, further research is necessary to verify the potential protective effect of calcium-rich dairy products against overweight and obesity.

In conclusion, the alarming rise in the prevalence of pediatric obesity in our population, coupled with inadequate calcium intake, represents a major public health concern and warrants the implementation of effective preventive and therapeutic strategies.

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